

# AN INTRODUCTION TO COMMUNICATION NETWORK ANALYSIS

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**George Kesidis**

*Pennsylvania State University*



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*For Selena, Emma and Cleo*





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# PREFACE

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This book was the basis of a single graduate course on the general subject of "performance" of communication networks for students from a broad set of backgrounds in electrical engineering, computer science, or computer engineering. The student was assumed to have basic familiarity with networking concepts as discussed in introductory texts on the subject, e.g., [139, 172, 220]. Also the student was assumed to have undergraduate courses in probability theory and linear (matrix) algebra.

Background material on probability and statistics is reviewed in Chapter 1. Graduate courses on probability and stochastic processes in electrical and computer engineering tend to focus on wide-sense stationary processes, typically in order to study the effects of noise in communication and control systems. In two successive chapters this book covers Markov chains and introduces the topic of queueing. Though the continuous-time context is stressed (to facilitate the queueing material), the discrete-time context is covered at the end of each chapter.

The remaining chapters pertain more directly to networking. Chapter 4 is on the subject of traffic shaping and multiplexing using a localized bandwidth resource. The next chapter describes queueing networks with static routing in the rather classical contexts of loss networks and open Jackson networks. Chapter 6 is on dynamic routing and routing with incentives including a game-theoretic model. The final chapter is a discussion of peer-to-peer networking systems, specifically those for the purposes of file sharing.

In general, problems at the end of each chapter review the described concepts and cover more specialized related material that may be of interest to the networking researcher. Worked solutions or references for certain problems are given in an appendix.

The length of the book allows time for about two weeks of lectures on material of specific interest to the instructor. The amount of instructor discretionary time can be increased by,